Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

6573217833

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **October/November 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 120.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **28** pages. Blank pages are indicated.

DC (PQ/CB) 192070/3

[Turn over

1 **(a)** Fig. 1.1 is a photomicrograph of sperm surrounding an egg cell.

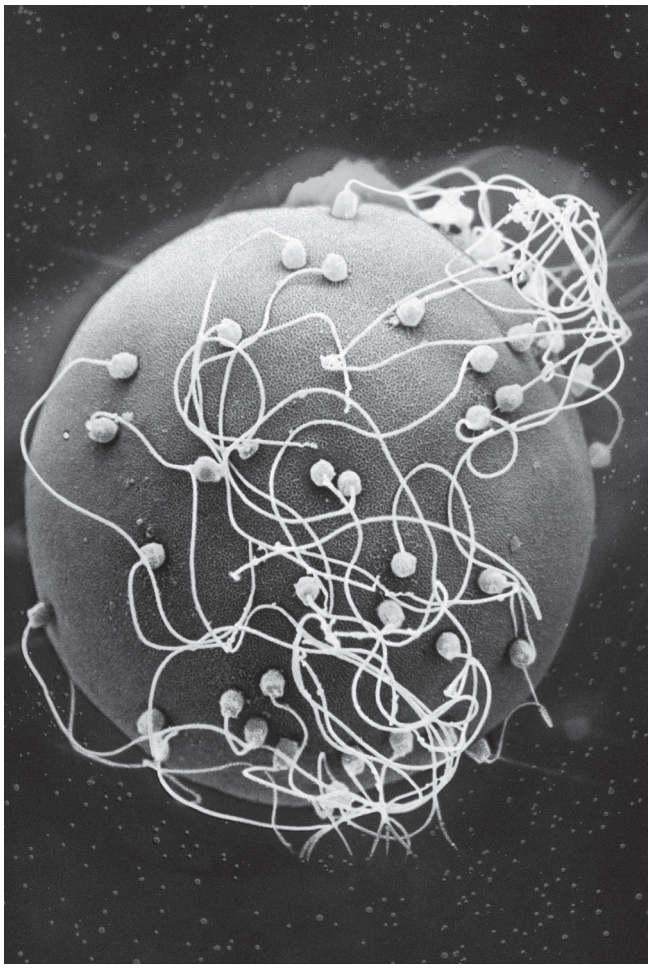

Fig. 1.1

(i) Describe **two** visible differences between the sperm cells and the egg cell shown in Fig. 1.1.

1 .....

.....

2 .....

.....

[2]

(ii) State **one** adaptive feature of sperm that is **not** visible in Fig. 1.1.

..... [1]

(b) The fusion of the nuclei from a sperm and an egg is called fertilisation.

(i) State where fertilisation occurs in the female reproductive system.

..... [1]

(ii) State **two** parts of the female reproductive system the sperm must pass through **before** fertilisation.

1 .....

2 .....
[2]

(iii) After fertilisation, the egg forms a layer that prevents more sperm entering the egg.

State the name of this adaptive feature.

..... [1]

(iv) Complete the sentence to describe the nucleus in a gamete.

Gametes contain a ..... nucleus containing a single set of

..... chromosomes. [2]

[Total: 9]

[Turn over

2 Atoms contain protons, neutrons and electrons.

(a) Complete Table 2.1 about protons, neutrons and electrons.

Table 2.1

	relative charge	relative mass	location in an atom
protons	.....	.....	in nucleus
neutrons	.....	1	.....
electrons	–1	.....	.....

[3]

(b) Fig. 2.1 shows the structure of an atom of nitrogen.

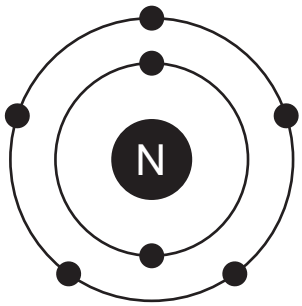

Fig. 2.1

(i) Write the electronic structure for a nitrogen atom.

..... [1]

(ii) Nitrogen is in Group V of the Periodic Table.

State how Fig. 2.1 shows that nitrogen is in Group V.

..... [1]

(c) Nitrogen atoms bond together to form nitrogen molecules, N_2.

Draw a dot-and-cross diagram to show the bonding in a nitrogen molecule.

Show only the outer shell electrons.

[2]

(d) Nitrogen is one of the gases found in clean air.

Complete Table 2.2 about the gases in clean air.

Table 2.2

gas	percentage (%) in clean air
carbon dioxide	0.041
oxygen	.....
nitrogen	.....
.....	varies

[3]

(e) Nitrogen monoxide gas, NO, is an air pollutant.

A catalytic converter removes nitrogen monoxide from car exhaust gases.

Write a balanced symbol equation for this reaction.

..... [2]

[Total: 12]

3 **(a)** A golfer swings her golf club to hit a stationary golf ball of mass 0.05 kg.

(i) State the kinetic energy of the golf ball **before** it is hit.

kinetic energy = ... J [1]

(ii) The speed of the golf ball immediately after it has been hit is 35 m / s.

Calculate the kinetic energy of the golf ball when it is moving at 35 m / s.

kinetic energy = ... J [2]

(b) When the golfer hits the ball, she hears a sound.

Sound waves are longitudinal waves and pass through the air as a series of compressions and rarefactions.

(i) State what is meant by a longitudinal wave.

.....

..... [1]

(ii) Describe **one** difference between a compression and a rarefaction.

.....

..... [1]

(iii) Fig. 3.1 shows a sound wave travelling through the air.

Fig. 3.1

On Fig. 3.1, label a compression with the letter **C** and a rarefaction with the letter **R**. [2]

(c) Part of a golf club is made of solid metal.

Explain why solids have a fixed shape.

Use ideas about the forces between atoms in your answer.

.....

..... [1]

[Total: 8]

4 **(a)** Researchers estimated the percentage of people that smoke tobacco in a country.

Fig. 4.1 shows the results.

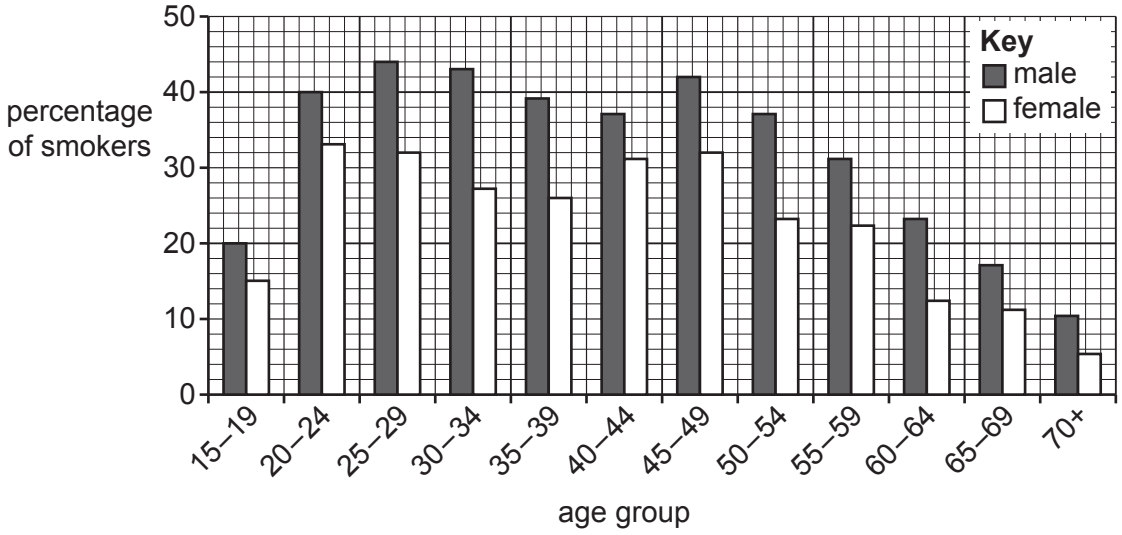

Fig. 4.1

(i) Describe **two** general trends shown by the data in Fig. 4.1.

1 .....

.....

2 .....

.....

[2]

(ii) Calculate the percentage of females that **do not** smoke tobacco in the 45–49-year-old age group.

..... % [1]

(b) There is a smaller percentage of the population that smoke tobacco compared to 50 years ago.

Suggest a reason for this.

.....

..... [1]

(c) Table 4.1 shows some of the major components of tobacco smoke and their effects on the body.

Complete Table 4.1.

Table 4.1

component of tobacco smoke	effect on the body
carbon monoxide	.....
.....	is an addictive substance
.....	causes cancer

[3]

(d) One of the effects of smoking tobacco is that ciliated cells lining the airways begin to die.

Explain the effects of this on the gas exchange system.

.....

.....

.....

.....

.....

..... [3]

(e) Smoking is one of the risk factors for coronary heart disease.

State **two other** risk factors.

1 .....

2 .....

[2]

[Total: 12]

5 Copper is a transition metal.

Transition metals form coloured compounds.

(a) Write down **two** other properties of transition metals that are **not** properties of all metals.

1 .....

2 .....

[2]

(b) Copper carbonate, $CuCO_3$, reacts with dilute hydrochloric acid, HCl.

Copper chloride, $CuCl_2$, is made.

$$CuCO_3 + 2HCl \longrightarrow CuCl_2 + H_2O + CO_2$$

(i) Copper chloride contains copper ions, Cu^{2+}, and chloride ions, Cl^-.

Describe the test and its positive result for chloride ions.

test .....

positive result .....

[2]

(ii) In an experiment, 4.0 g of copper carbonate reacts with excess dilute hydrochloric acid.

Calculate the maximum mass of copper chloride that can be made.

[A_r: C, 12; Cl, 35.5; Cu, 64; O, 16]

mass of copper chloride = ... g [2]

(iii) In another experiment, 8.8 g of carbon dioxide gas is made.

Calculate the volume of carbon dioxide gas **in cm^3** at 25 °C.

The molar gas volume at 25 °C is 24 dm^3.

[A_r: C, 12; O, 16]

volume of carbon dioxide = ... cm^3 [4]

(c) Explain why copper is a conductor of electricity.

Use ideas about metallic bonding.

.....

..... [2]

[Total: 12]

6 **(a)** A horse of mass 450 kg accelerates constantly from rest and reaches a maximum speed of 9 m/s after 3 seconds. In this time, the horse has travelled 13.5 m.

(i) Show that the force that causes the acceleration of the horse is 1350 N.

[3]

(ii) Calculate the work done by the horse in travelling 13.5 m.

work done = ... J [2]

(b) The horse stands with all four hooves in contact with the ground.
The horse exerts a force of 4500 N on the ground.

Each hoof of the horse has an area of 90 cm^2.

Calculate the pressure, in N/m^2, exerted by the horse on the ground.

pressure = ... N/m^2 [3]

(c) Horseshoes are usually made from either iron or steel.

Describe **one** difference between the magnetic properties of iron and steel.

.....

..... [1]

(d) The audible frequency range for horses is from 14 Hz to 25 000 Hz.

Compare this range to that of a human.

.....

..... [1]

(e) A horse is treated for cancer using the isotope iridium-192. The iridium-192 is injected into the cancer.

Iridium-192 decays by β-emission to produce an isotope of platinum.

Use nuclide notation to complete the symbol equation for the β-decay process.

$$^{192}_{77}\text{Ir} \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}\text{Pt} + {}^{\cdots\cdots}_{\cdots\cdots}\beta$$

[2]

[Total: 12]

7 **(a)** Table 7.1 shows the effects of using fertilisers containing nitrate ions on the yield of pea plants.

The yield is the mass of peas produced per square metre.

Table 7.1

application of fertiliser	yield / g per m^2
fertiliser containing nitrate ions used	340
no fertiliser used	120

(i) Calculate the percentage increase in yield when using fertilisers containing nitrate ions.

Give your answer to the nearest whole number.

..... % [2]

(ii) Explain why adding nitrate to pea plants increases the yield of peas.

.....

.....

.....

..... [3]

(b) Peas can be wrinkled or round.

Fig. 7.1 is a photograph of a wrinkled pea and a round pea.

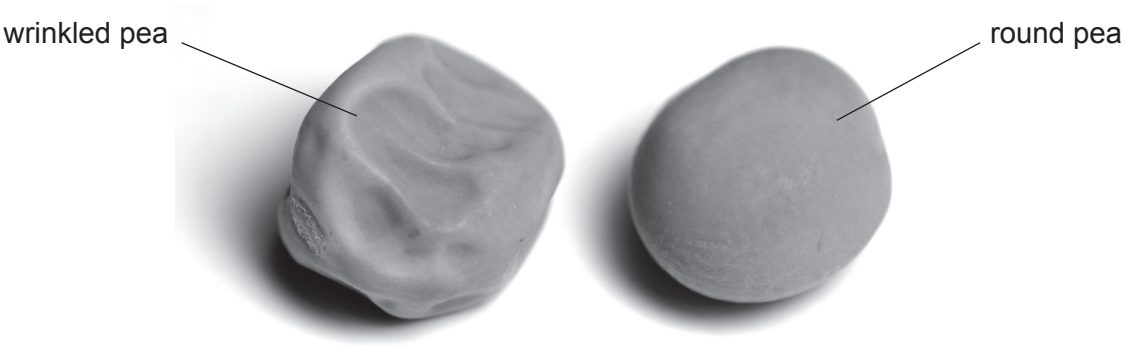

Fig. 7.1

Peas inherit the wrinkled or round feature from their parent plants.

- The dominant allele for round peas is **R**.
- The recessive allele for wrinkled peas is **r**.

Use your knowledge and this information to complete Table 7.2.

Table 7.2

genotype for wrinkled peas	
phenotype of a pea with a heterozygous genotype	
the type of breeding if two wrinkled pea plants were crossed	

[3]

(c) Peas contain a store of carbohydrates made during photosynthesis.

(i) Describe **two other** uses of the carbohydrates made during photosynthesis.

1 .....

.....

2 .....

.....

[2]

(ii) List the **three** chemical elements present in carbohydrates.

..... [1]

[Total: 11]

8 A student investigates the reaction between sodium thiosulfate solution and dilute hydrochloric acid.

Fig. 8.1 shows the apparatus the student uses.

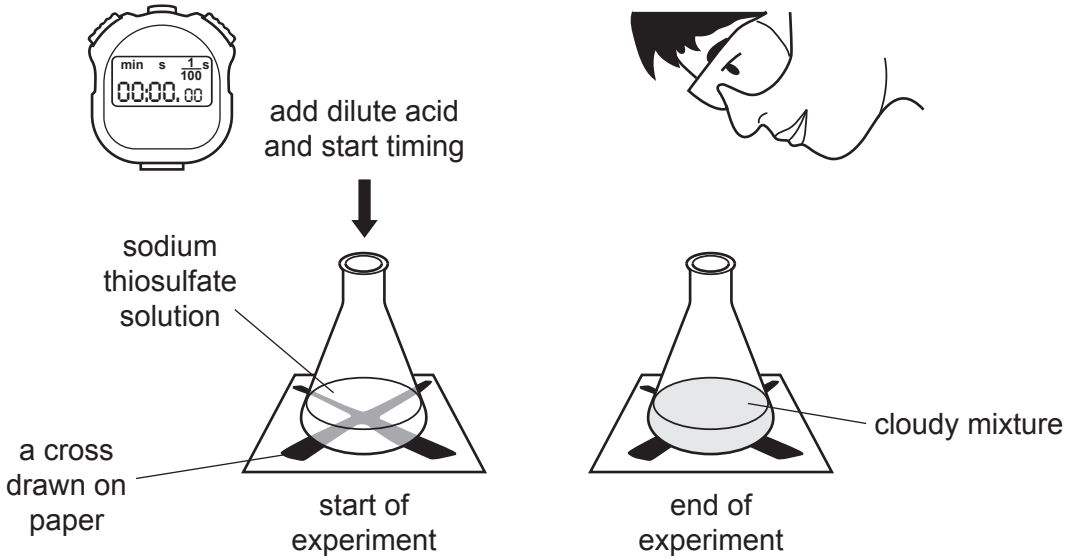

Fig. 8.1

The student looks down at the cross drawn on the paper.

A solid is made during the reaction and the mixture in the flask becomes cloudy.

At the moment she adds the dilute acid, the student starts a stop-watch.

She measures the time it takes until she can no longer see the cross.

The student does four experiments. She uses different concentrations, **A**, **B**, **C** or **D**, of sodium thiosulfate each time.

She does all the experiments at 20 °C and keeps the concentration of hydrochloric acid constant.

Table 8.1 shows her results.

Table 8.1

concentration	time taken for cross to disappear / s
A	39
B	78
C	127
D	61

(a) Look at the student's results.

State which is the **most concentrated** solution of sodium thiosulfate.

Choose from **A**, **B**, **C** or **D**. .....

Explain your answer.

.....

..... [2]

(b) The rate of the reaction can be increased by **increasing** the temperature of the reaction mixture to 45 °C.

Explain why.

Use ideas about collisions between particles.

.....

.....

.....

..... [3]

(c) The reaction between sodium thiosulfate solution and dilute hydrochloric acid is **exothermic**.

Explain why.

Use ideas about bond forming and bond breaking.

.....

.....

.....

..... [3]

[Total: 8]

[Turn over

9 **(a)** The information booklet about an oven states that the weight of the oven is 45 kg.

Explain why this statement is incorrect.

.....

..... [1]

(b) **(i)** Fig. 9.1 shows information on a label attached to the electric oven.

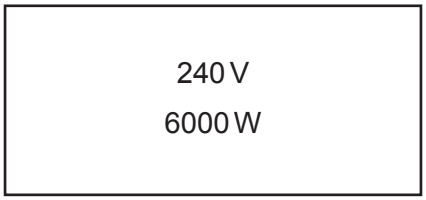

Fig. 9.1

Use Fig. 9.1 to calculate the maximum working current of the oven.

current = ... A [2]

(ii) The oven has its own fuse.

Use your answer to **(b)(i)** to explain why a fuse rated at 13 A is not suitable for use in the oven circuit.

.....

.....

..... [1]

(c) A thermocouple is used to measure the temperature inside the oven.

Describe the structure of a thermocouple.

You may draw a diagram if it helps your answer.

.....

.....

..... [2]

(d) Some water is heated in a dish in the oven. As the water is heated, some of the water evaporates. Eventually the water begins to boil.

Describe **two** differences between evaporation and boiling.

1 .....

.....

2 .....

.....

[2]

[Total: 8]

10 (a) The temperature of a person's skin is recorded in different environmental temperatures.

Fig. 10.1 shows the **two** parts of the skin where the readings are taken.

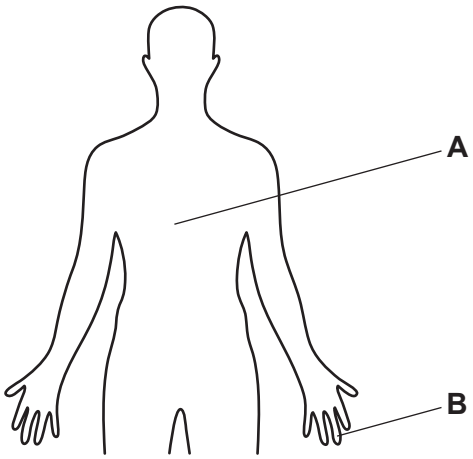

Fig. 10.1

Table 10.1 shows the results.

Table 10.1

	temperature of the skin / °C		
part of body	cold environment (15 °C)	warm environment (27 °C)	hot environment (47 °C)
A	30.1	34.4	35.8
B	23.7	33.8	36.7

(i) Describe how the skin responds to **cold** temperatures in order to maintain a constant internal body temperature.

.....

.....

.....

.....

.....

..... [3]

(ii) Suggest why the temperature range of the skin on part **A** is less than on part **B**.

.....

.....

.....

..... [2]

(b) Body temperature is controlled to keep it within set limits.

Name the term used to describe this.

..... [1]

(c) Temperature control of the body shows that humans have sensitivity to their environment.

Define *sensitivity*.

.....

.....

.....

..... [2]

[Total: 8]

11 Propane and propene are both hydrocarbons.

Fig. 11.1 shows the structure of a propene molecule.

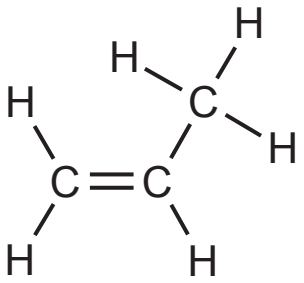

Fig. 11.1

(a) Draw the structure of a propane molecule.

[1]

(b) Aqueous bromine is used to tell the difference between propane and propene.

Describe the colour change, if any, that is seen when aqueous bromine is added to propane and to propene.

propane .....

propene .....

[2]

(c) Cracking is used to make propene.

Describe cracking.

Include what happens to the large hydrocarbon molecules during cracking, and the conditions needed for cracking.

.....

.....

.....

.....

.....

..... [4]

(d) Fig. 11.2 shows the structure of a chloropropene molecule.

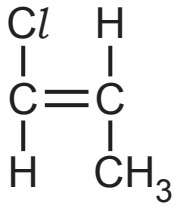

Fig. 11.2

Chloropropene is used to make the polymer poly(chloropropene).

Draw the structure of poly(chloropropene).

[1]

[Total: 8]

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12 **(a)** Fig. 12.1 shows a truck crossing a bridge.

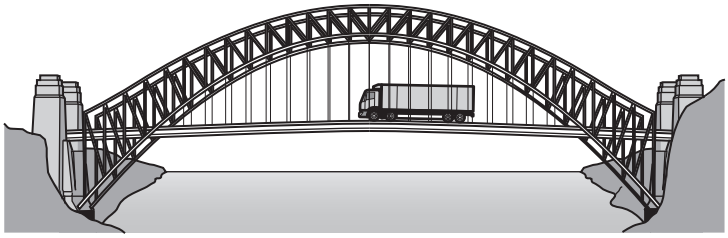

Fig. 12.1

The bridge is designed with gaps in the road surface as shown in Fig. 12.2.

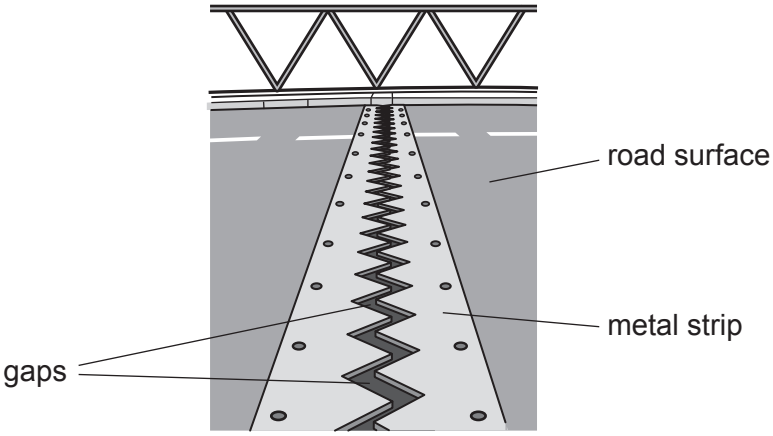

Fig. 12.2

The temperature of the road surface increases on a hot day.

(i) Describe what happens to the gaps in the road surface when the temperature increases.

Explain your answer.

.....

.....

..... [2]

(ii) Suggest what may happen to the bridge if there were no gaps in the road surface.

.....

..... [1]

(b) Fig. 12.3 shows the fuel tank of the truck being filled with diesel fuel.

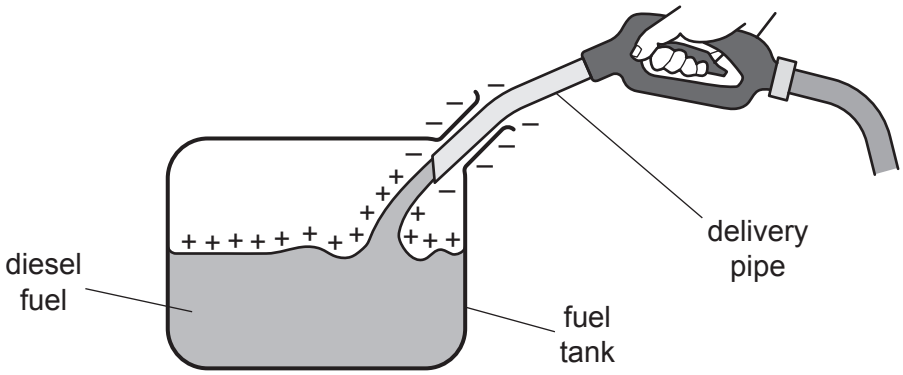

Fig. 12.3

Explain why the diesel fuel becomes positively charged.

.....

.....

..... [2]

(c) The truck has a warning triangle to alert other drivers.

Fig. 12.4 shows the warning triangle.

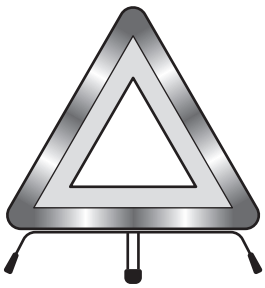

Fig. 12.4

Many tiny prisms are contained in the warning triangle.

Fig. 12.5 shows one ray of light entering a prism.

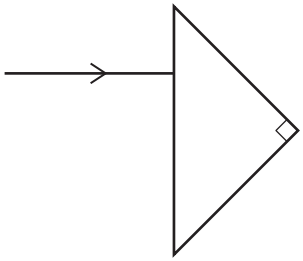

Fig. 12.5

The ray undergoes total internal reflection inside the prism.

Complete Fig. 12.5 to show the path of the ray of light through the prism and the ray of light leaving the prism. [2]

(d) The truck has a generator.

Fig. 12.6 shows a simple generator producing an alternating voltage.

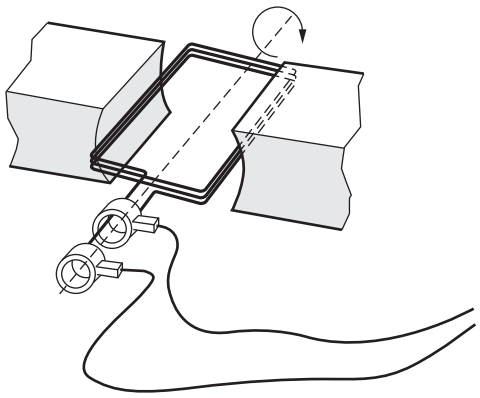

Fig. 12.6

(i) On Fig. 12.6, label the coil **C**. [1]

(ii) On Fig. 12.6, label the slip rings **S**. [1]

(iii) Describe how turning the coil induces an alternating voltage.

.....

.....

.....

..... [3]

[Total: 12]

The Periodic Table of Elements

Group I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			**Key** atomic number atomic symbol name relative atomic mass								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is $24\,dm^3$ at room temperature and pressure (r.t.p.).